PB-230 493

STREAM POLLUTION BY COAL MINE DRAINAGE, CAPTINA CREEK BASIN, OHIO

Federal Water Pollution Control Administration
Wheeling, West Virginia

March 1968

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STREAM POLLUTION BY COAL MINE DRAINAGE

CAPTINA CREEK BASIN, OHIO

Work Document No. 23

This document has been prepared to record a specific water pollution control activity carried out to date in furtherance of the water pollution control program being developed in the Ohio River Basin. The information contained herein will serve as a ready reference to aid in the planning and development of the program in the Basin, for appropriate in-service training of participating personnel, and facilitating program activities with other cooperating groups.

Questions or comments relative to this material should be directed to:

Mine Drainage Unit
Planning and Evaluation Section
Wheeling Field Station

UNITED STATES DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
OHIO BASIN REGION

March 1968

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INTRODUCTION

In August 1966, the Wheeling Field Station was contacted by the Powhatan Improvement Committee, Powhatan Point, Ohio, relative to mine drainage pollution conditions in Captina Creek. The local citizens' committee expressed concern over the stream's quality and requested assistance in determining the extent and sources of pollution to facilitate local action for pollution abatement. Subsequently, field observations of stream quality and sources of mine drainage were conducted by FWPCA personnel.

The conclusions and recommendations herein are subject to refinement as the program of the Ohio River Basin Project progresses.

The generous assistance of officials of the North American Coal Corporation, Powhatan Division, and the Oglebay-Norton Coal Company is gratefully acknowledged.

DESCRIPTION OF AREA

Captina Creek rises in southwestern Belmont County, Ohio and flows east some 39 miles to the Ohio River at Powhatan Point, Ohio. The drainage area is 181 square miles and the average fall of the main stream is 16 feet per mile. The basin is elongate in shape, measuring about 25 miles long in its east-west dimension, and is about 10 miles wide at its maximum north-south dimension. The principal tributaries to Captina Creek are North Fork, South Fork, and Bend Fork.

The Captina Creek basin is bounded on the north by McMahon Creek and on the south by Sunfish Creek, both tributaries to the Ohio River. The Muskingum River basin forms the western boundary and the Ohio River forms the eastern boundary.

This area is part of the Appalachian Plateaus physiographic province, which is a broad dissected upland underlain by essentially horizontal sedimentary rocks. Streams have dissected the area so that most of its plateau surface is no longer evident. The present surface consists mainly of broad, rounded ridges and intervening valleys. The valleys are deep and narrow near the Ohio River but are shallower and broader headward near the drainage divides.

The principal communities in the watershed are Barnesville and Powhatan Point which had populations of 4425 and 2147, respectively, in 1960.

GEOLOGY

The exposed strata of Belmont County were deposited during the Pennsylvanian and Permian periods in an uninterrupted sequence with an aggregate thickness of 1,100 feet. They consist of interbedded sheets of sandstone, siltstone, clay mudstone, limestone and coal. The lithologic types comprise the upper 350 feet of the Conemaugh formation, the Monongahela formation of Pennsylvanian age, and the lower 470 feet of the Dunkard group of Pennsylvanian and Permian age. Within these formations, 56 members and coal beds are recognized and named.

The strata dip to the southeast at an average rate of 18 feet per mile over the county. Small local deformations cause slight variations in the dip, which in a few places is as much as 60 to 70 feet per mile.

Coal Reserves

There are 15 coal beds exposed in Belmont County. The Pittsburgh and Sewickley beds are the only two currently being mined commercially. Seven of the 15 beds contain mineable reserves. The other eight beds are not considered mineable because of erratic occurrence, poor quality, and insufficient thickness.

In the Captina Creek watershed, all seven of the coal beds considered mineable in Belmont County are present and contain mineable reserves. The largest reserve, about 40 percent of the estimated watershed total, is contained in the Pittsburgh (No. 8) bed. The second largest reserve is contained in the Sewickley (No. 9) bed. Recoverable coal reserves in the Captina Creek watershed are estimated to be in excess of 1200 million tons.

MINING HISTORY

The mining of coal in Belmont County probably did not begin until about 1804 when coal was mined from an exposure along Pipe Creek. The presence of coal, however, must have been known to the earliest settlers from the numerous outcrops throughout the county.

Early mining was limited to small openings and stripping operations along the coal outcrops and was mainly for local home consumption. Belmont County coal was used largely for domestic purposes until 1830. In that year a commercial underground mine was opened on the south bank of McMahon Creek at Bellaire. Between 1835 and 1840 other mines were opened along the Ohio River in the county, and

by 1845 shipment of coal along the river was an active enterprise.

By 1888 the distribution of underground commercial mines throughout the county was in about the same pattern that exists today. Most of the large mines were in the northeastern quarter of the county, but several were operating elsewhere. The Captina Mine, located on Captina Creek three-fourths of a mile east of Armstrongs Mills, produced coal for shipment by narrow gage railroad.

After 1888 the coal mining industry grew steadily, and in 1905 Belmont County led the State in production. The county has led coal production in Ohio almost continuously since 1905. The rapid increase in strip mining since World War II has added greatly to annual tonnages produced in recent years.

In the Captina Creek watershed, mining records show the existence of at least 78 underground mine locations and a few small strip mine locations.

Coal Production

Total reported coal production in Belmont County over the period of record is about 500 million tons. Total production for 1966 was 8.3 million tons from reporting mines. Production was divided between surface and underground mining operations in the ratio of 3.4 million tons to 4.9 million tons, respectively.

In reporting year 1966, significant coal production in the Captina Creek drainage basin was from three underground mines. The mines are located in the Pittsburgh (No. 8) seam. The reported production from these operations in 1966 is listed in Table 1:

Table 1
1966 coal production
Captina Creek watershed

Mine	Production (Tons)
Oglebay Norton Co., Norton Mine	896,279
North American Coal Corp., Powhatan Div., Powhatan No. 1 Mine*	818,468
North American Coal Corp., Powhatan Div., Powhatan No. 5 Mine.	445,026
TOTAL	2,159,773

*Does not include tonnage mined in Monroe County from this mine.

STREAM WATER QUALITY

Portions of the Captina Creek basin contain streams whose water quality has been degraded by mine drainage. The principal affected area is the lower reach of Captina Creek which is subject to backwater conditions from lock and dam operations on the Ohio River. Approximately the lower one to 1-1/2 miles of the stream are affected by the ponding or retarded flow conditions. When the Ohio is in high flow conditions the backwater area extends further upstream.

Near-stagnant conditions, particularly in low-flow periods, serve to accumulate pollution contituents originating upstream. The most obvious feature is that of iron compounds in the stream from upstream coal mine discharges. Dissolved iron precipitates in the slack-water area and presents a yellow, murky, unpalatable appearance. It is a reminder that the usually clear stream above the backwater area does carry polluting constituents.

During a 1966 sampling period, chemical analyses were performed on six stream samples from Station No. 1686, Captina Creek at Route 7 bridge. A statistical summary of this data is shown in Table 2. These analyses are probably representative of the worst conditions because of low streamflow at time of sampling. The maximum flow during the study period was only seven cubic feet per second. Average flow in Captina Creek at Armstrong Mills, Ohio over the 16-year period of record (1926-1935, 1958-1965) is 151 cubic feet per second.

Acidity concentrations exceeded alkalinity concentrations on only one occasion. The pH was 5.3 and the acidity was 61 milligrams per liter (mg/l) at this time. Alkalinity was not depleted on any sampling occasion. The specific conductance values ranged from 650 to 1000 and represent a moderate to high degree of mineralization of the stream. Total hardness, sulfate, iron, manganese, and aluminum were all above concentration levels representing desirable or good water quality.

In summary, Captina Creek at the Route 7 location possesses degraded water quality from the effects of mine drainage. The stream is not normally acidic but is subject to periodic acid conditions (i.e., acidity concentration in excess of alkalinity concentration) from coal mine drainage. Backwater resulting from the navigation pool level of the Ohio River aggravates conditions in the lower reach.

With few local exceptions, Captina Creek above the backwater area was of acceptable quality on the basis of field pH and specific

Table 2
Surface Water Quality
Physical and Chemical Data
Captina Creek, Ohio Watershed

Station No. 1686 - Captina Creek at Route 7 Bridge

PHYSICAL OBSERVATIONS

PARAMETER	NUMBER OF SAMPLES	MAXIMUM VALUE	MINIMUM VALUE	AVERAGE VALUE
Temperature	6	30.0	23.0	26.8
pH	6	6.8	5.3	6.4
Specific Conductance*	6	1000	650	768
Flow (cfs)**	6	7.0	1.8	4.2

CHEMICAL OBSERVATIONS

PARAMETER	NUMBER OF SAMPLES	MAXIMUM VALUE (mg/l)	MINIMUM VALUE (mg/l)	AVERAGE VALUE (mg/l)	MAXIMUM VALUE (lbs/day)	MINIMUM VALUE (lbs/day)	AVERAGE VALUE (lbs/day)
Dissolved Oxygen	6	7.9	6.2	7.1	287	60	165
Acidity	6	61	0	14	2007	0	373
Alkalinity	6	83	5	49	3134	165	1110
Hardness	6	381	295	334	11,187	3320	7275
Sulfate	6	500	144	241	16,451	1476	6119
Total Iron	6	19.2	0.5	4.7	632	13	134
Manganese	6	2.9	1.3	1.7	95	14	40
Aluminum	6	4.4	1.0	2.4	147	10	55
Chloride	2	35	28	32	936	374	637

*Micromhos/Centimeter
**Cubic Feet Per Second

conductance determinations made during the study period. Available published chemical data at various main stream locations corroborate these field observations.

Field pH and specific conductance determinations were made at a number of stream locations in the watershed during the mine drainage source investigation. These readings are listed below in Table 3 in upstream order.

These stream observations, and the mine drainage source investigation, indicate that mine drainage pollution in the Captina Creek basin does not normally occur upstream of the Oglebay-Norton Company, Norton Mine location (Figure 1). Although seasonal or intermittent abandoned mine discharges may occur in the upper basin area, available data indicate little effect upon the stream.

MINE DRAINAGE SOURCES

Twelve points of mine drainage were located and documented as significant sources of mineralized discharges received by Captina Creek and its tributaries. The mine drainage emanates from active and inactive underground mines and mine refuse areas. An additional large number of inactive or abandoned mines exist in the watershed but were dry or causing only minor seepage at the time of inspection (Figure 1). Some of these mines undoubtedly contribute mine drainage to streams during wet periods.

Quantity and quality data for significant mine drainage waste discharges in the Captina Creek watershed are presented in Table 4. Although there are a large number of abandoned drift mines upstream from this point (Figure 1), the first mine discharge received by Captina Creek is from the Norton Mine (Mine No. 2358) located along Captina Creek just above its confluence with Pea Vine Creek. This operation consists of a slope mine and coal preparation plant. The pumped discharge from the mine runs at the rate of 72 gallons per minute (gpm) for about six minutes each hour. This is equivalent to a daily average discharge of 7 gpm. The discharge water is strongly alkaline and contains high concentrations of sulfate, hardness, and metals (Table 4).

Adjacent to the mine on the east side is a refuse area for solid wastes from the mine and preparation plant operations. At the time of the survey, surface drainage from this area amounted

Table 3
Field Observations
Captina Creek and Tributaries

STREAM	pH	SPECIFIC CONDUCTANCE (micromhos/cm)	REMARKS
Porters Run at mouth	--	450	
Captina Cr. at Rte. 148	6.7	580	
Cat Run at mouth	7.8	675	No mine discharge at time of survey
Cat Run above mine location	7.5	440	No mine discharge at time of survey
Peavine Cr. at mouth	7.7	3200	Receives pump discharge.
Captina Cr. above Oglebay-Norton Mine	7.8	360	
Captina Creek near Anderson Run	7.2	380	
Rocky Fork at Rte. 148	7.0	650	
Bend Fork at mouth	7.7	410	
Millers Run to Bend Fork	8.0	420	
Joy Fork to Bend Fork	7.8	400	
Packsaddle Run to Bend Fork	7.7	420	
Casey Run at mouth	8.0	400	
Berrys Run at mouth	8.0	500	
Mikes Run at mouth	8.1	440	
South Fork at mouth	8.0	500	
Flag Run to South Fork	8.3	420	
Cranenest Creek to So. Fork	8.0	460	
Unnamed trib. to North Fork	8.0	500	
Long Run to North Fork	7.8	500	

Table 3
Field Observations
Captina Creek and Tributaries
(Continued)

STREAM	pH	SPECIFIC CONDUCTANCE (micromhos/cm)	REMARKS
North Fork below Barnesville	7.5	---	
South Fork at Route 8	7.6	440	
Millers Run to South Fork	8.0	350	

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Table 4

Mine drainage data, Captina Creek watershed

MINE NO.	NAME	SOURCE TYPE	RECEIVING STREAM	FLOW (gpm)	ACIDITY		ALKALINITY		HARDNESS		SULPHATES	
					mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day
1753	N.Am.Coal Corp., Powhatan Division	Mine refuse area	Unnamed trib. to Captina Creek	40	10,700	5136	00	-	1530	734	10,000	4800
1754	Kish Mine	Abandoned drift mine	Captina Creek	8	1,230	118	00	-	1005	96	1,850	17
1756	Oglebay-Norton Co. Norton Mine	Mine refuse area	Captina Creek	3	34,300	1235	00	-	600	22	24,250	87
2348		Abandoned drift mine and refuse area	Captina Creek	25	156	47	00	-	214	64	435	13
2349		Abandoned drift mine	Captina Creek	12	3	0.4	216	31	122	18	410	5
2358	Oglebay-Norton Company Norton Mine	Active Slope mine	Captina Creek	7 1/	4	0.3	529	44	1360	114	1620	13

Table 4

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Mine drainage data, Captina Creek watershed

ACIDITY		ALKALINITY		HARDNESS		SULPHATES		TOTAL IRON		MANGANESE		ALUMINUM		pH	COND.
mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day		
0,700	5136	00	-	1530	734	10,000	4800	31.2	15	53.1	40	2195	1054	2.8	10,48C
1,230	118	00	-	1005	96	1,850	178	216.0	21	1.6	.15	120.0	12	3.1	3,00C
4,300	1235	00	-	600	22	24,250	873	936.0	34	0.8	.30	6020	217	1.9	21,50C
156	47	00	-	214	64	435	131	22.0	7	0.9	.30	-	-	3.6	1,100
3	0.4	216	31	122	18	410	59	18.2	3	0.2	.03	-	-	6.3	850
4	0.3	529	44	1360	114	1620	136	-	-	-	-	-	-	6.7	2,20C

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Table 4 (continued)

MINE NO.	NAME	SOURCE TYPE	RECEIVING STREAM	FLOW (gpm)	ACIDITY		ALKALINITY		HARDNESS		SULPHATES		TOT
					mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l
2353	N.Am.Coal Corp. Powhatan Div. Powhatan No. 1 Mine	Active shaft mine (Cat's Run Slope)	Cat Run	17 2/	345	70	0	-	432	88	2660	543	225
2354	N.Am.Coal Corp. Powhatan Div. Powhatan No.1 Mine	Active shaft mine (Cat's Run #37 South)	Cat Run	26 3/	13	4	273	85	105	33	240	75	5.8
2355	N.Am.Coal Corp. Powhatan Div. Powhatan No.1 Mine	Active shaft mine (Cat's Run Return Shaft)	Cat Run	38 4/	16	7	155	71	170	78	185	84	1.5
2356	N.Am.Coal Corp. Powhatan Div. Powhatan No.1 Mine	Active shaft mine (Pea Vine Bore-hole)	Unnamed trib. to Pea Vine Creek	70	120	101	333	280	408	343	525	441	267.5

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Table 4 (continued)

CIDITY		ALKALINITY		HARDNESS		SULPHATES		TOTAL IRON		MANGANESE		ALUMINUM		pH	COND.
	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day		
5	70	0	-	432	88	2660	543	225	46	1.9	.40	14.8	3	5.1	2,700
3	4	273	85	105	33	240	75	5.8	2	0.2	.06	0.0	-	5.9	2,200
6	7	155	71	170	78	185	84	1.5	1	0.0	-	0.0	-	6.4	700
0	101	333	280	408	343	525	441	267.5	225	1.2	1	0.6	0.5	6.5	8,440

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Table 4 (continu i)

MINE NO.	NAME	SOURCE TYPE	RECEIVING STREAM	FLOW (gpm)	ACIDITY		ALKALINITY		HARDNESS		SULPHA
					mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l
2357	N.Am.Coal Corp. Powhatan Div. Powhatan No.1 Mine	Active shaft mine (New Cat's Run Portal)	Unnamed trib. to Cat Run	2 5/	0	-	1060	25	20	0.5	185
2359	N.Am.Coal Corp. Powhatan Div. Powhatan No.5 Mine	Active drift mine	Captina Creek	9 6/	24	3	245	26	208	22	450
			Totals	257		6722		562		1613	

1/ Pump discharge - 72 gpm - 6 min/hr, 7 gpm/24 hrs.

2/ Pump discharge - 100 gpm - 4 hr/day, 17 gpm/24 hrs.

3/ Pump discharge - 300 gpm - 2 hr/day, 26 gpm/24 hrs.

4/ Pump discharge - 300 gpm - 3 hr/day, 38 gpm/24 hrs.

5/ Pump discharge - 50 gpm - 1 hr/day, 29 gpm/24 hrs.

6/ Pump discharge - 75 gpm - 3 hr/day, 9 gpm/24 hrs.

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Table 4 (continu 1)

ACIDITY		ALKALINITY		HARDNESS		SULPHATES		TOTAL IRON		MANGANESE		ALUMINUM		pH	COND.
mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day		
0	-	1060	25	20	0.5	185	4	1.8	.04	0.2	-	0.2	-	8.6	3,50
24	3	245	26	208	22	450	49	1.7	.20	0.4	.04	0.4	0.04	7.0	3,00
	6722		562		1613		7373		354		41		1287		

hrs.

4 hrs.

24 hrs.

24 hrs.

/24 hrs.

hrs.

to three gpm of very acid and highly mineralized drainage (Mine No. 1756). The acidity concentration was 34,300 milligrams per liter (mg/l) and the daily acid load represented by this flow was 1235 pounds per day (lbs/day).

There was no discharge from the Oglebay-Norton Company's preparation plant waste settling ponds at the time of the survey, but black water conditions in Captina Creek due to discharges from these ponds have been observed at other times.

Just downstream from the Norton Mine, Pea Vine Creek enters Captina Creek carrying mine drainage water from a borehole discharge of the Powhatan No. 1 Mine. The discharge is located about one mile above the mouth of Pea Vine Creek (Mine No. 2356) and is pumped at the rate of 70 gpm. The discharge is alkaline and highly mineralized. The total iron load from this discharge is 225 lbs. per day, the largest iron contribution in the watershed.

Mine No. 1754 is located just downstream of Route 148 bridge on the south bank of Captina Creek (Figure 1). This effluent is from the old Kish Mine and is piped under Route 148 and discharged just above stream level. This discharge flows at the rate of 8 gpm, is strongly acid in character, and contributes a daily acid load of 118 pounds to Captina Creek.

Mine No. 2359 is an active drift mine of the North American Coal Corp., Powhatan No. 5 Mine. Drainage is pumped from this mine at a rate of 75 gpm for three hours each day, or, a daily average of 9 gpm. This discharge is alkaline and carries small quantities of iron and associated metals.

Mine No. 2348 is located a short distance downstream and on the opposite bank from No. 2359 (Figure 1). A discharge flows from an old drift mine property that has been covered with mine refuse material. A house has been constructed on the leveled surface. Twenty-five gpm of acid drainage was measured emerging from the base of the fill material. The acid load from this source is 47 lbs. per day.

Mine No. 2349 (Figure 1) is an abandoned drift mine discharging 12 gpm of alkaline water.

Cat Run, tributary to Captina Creek near Powhatan Point, receives four pump discharges from the Powhatan No. 1 shaft mine. Drainage from Mine No's. 2353, 2354, and 2355 is discharged near the Cat's Run Shaft from separate areas of the mine. These three discharges operate on individual pumping schedules but their aggregate discharge is equivalent to 81 gpm over a 24-hour day. The discharge from Mine No. 2353 is acidic, but discharges from Nos. 2354 and 2355 are alkaline (Table 4). The daily acid load discharged to

Cat Run from Mine No. 2353 is 70 lbs.

Near the headwaters of Cat Run, the New Cat's Run Portal of the Powhatan No. 1 Mine (Mine No. 2357) has a pumped discharge. The pump operates at the rate of 50 gpm for one hour per day, an average of 2 gpm for a 24-hour period. This water is strongly alkaline, 1060 mg/l, and only slightly high in total iron concentration (Table 4).

The last significant drainage point in the watershed, and the nearest to the mouth of Captina Creek, is Mine No. 1753. The drainage emanates from a large mine refuse area currently used by the North American Coal Corporation. The refuse pile has been built in a minor valley so that much of the discharge at the lower end of the pile has flowed down the buried valley, through the refuse pile. Although flow fluctuations are probably very wide, at the time of sampling the measured flow was 40 gpm. The drainage was strongly acid and contributed 5,136 lbs/day of acidity to Captina Creek at that flow condition. This acidity was by far the largest amount encountered in the Captina Creek watershed.

In summary, four of the 12 discharges were found to be acid in character and the total acidity load from all sources exceeded the total alkalinity of the sources by some 6,000 lbs/day. Using the average lbs/day loading values in Table 2 for comparison, the mine drainage sources contributed essentially all of the sulfate and iron content of Captina Creek and about one-fourth of the hardness content. The 6,700 lbs/day of acidity discharged to the streams of the watershed is usually adequately neutralized by the stream alkalinity in Captina Creek. The total mine drainage source iron loading equals 354 lbs/day. The total mine drainage source flow measured was 257 gpm.

RECOMMENDATIONS

Two basic measures are needed to control existing and potential water pollution by coal mine drainage in the Captina Creek watershed. These measures are needed to reduce concentrations of corrosive materials, reduce excessive salinity, and improve aesthetic conditions for the protection of potential water uses.

The following recommended actions are based on water quality data and field observations presented in this document:

1. The State of Ohio should adopt the necessary standards and regulations to prevent pollution of streams by drainage from active coal mines and related operations. The standards should include values for pH, sulfate, and total iron.

2. The amounts of polluting drainage from abandoned mine locations does not warrant the establishment of a mine drainage abatement program for such sources at the present time. Control should be established now, however, pertaining to the inactivation or abandonment of mines currently operating so that the amounts of additive harmful drainage produced after abandonment will be minimal.

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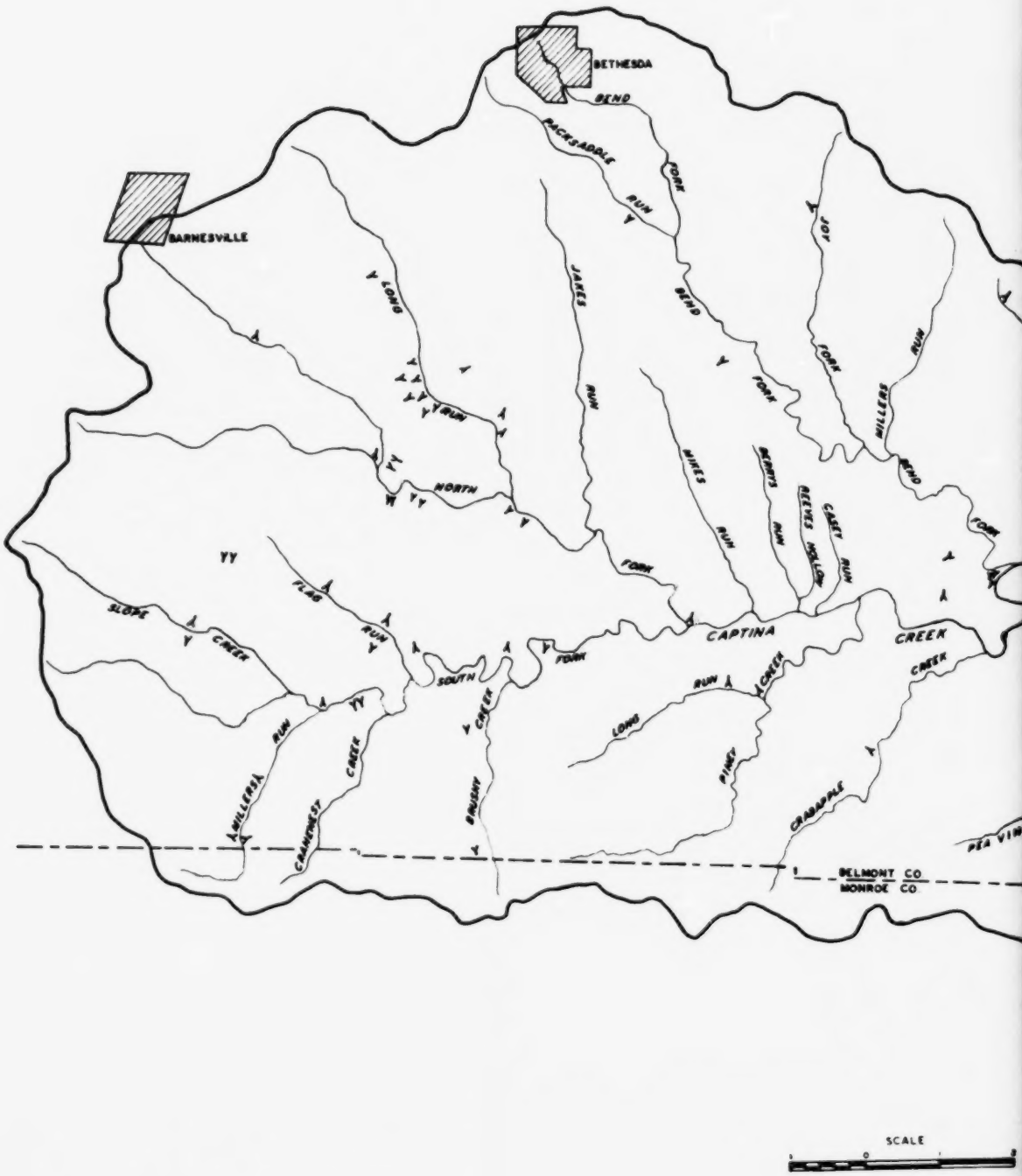
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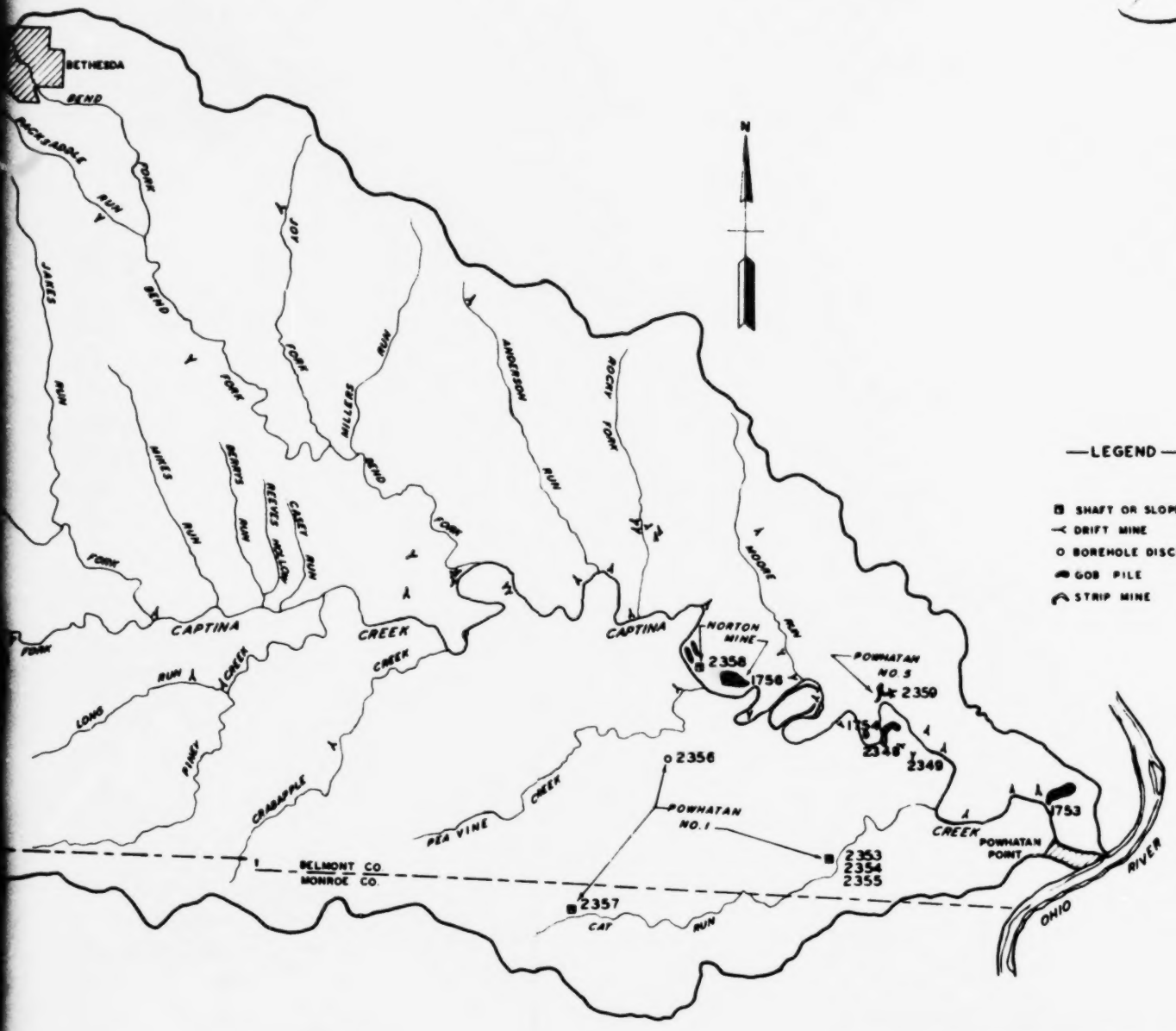

MINE LOCATIONS
CAPTINA CREEK, OHIO

UNITED STATES DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
OHIO BASIN REGION – WHEELING FIELD STATION

FIGURE 1